

# ALS Update

2005 Users' Meeting

10/20/2005

Janos Kirz

Support users in doing  
outstanding science  
In a safe environment

- User growth => More safety concerns
- Beamline growth => More crowded conditions
- Even though there are many weekly walkthroughs:
  - Please **notify** beamline coordinators or Georgeanna **of important changes in experiments:**
    - HV, floating power supplies, or HV batteries
    - Hazardous gases or chemicals
    - Any biological material (including soil samples)
    - Radioactive materials
    - Changes to laser-setups!!!

- Do not work on any equipment where there is a possibility to come in contact with:

High Voltage

> 50 volts and 5 milliamps (electric shock hazard) or

High Current

Any voltage but hundreds of amps (arc blast; electrical burns)

Ask EM's for help: X 5457

- 2 person rule in user shop
- New safety video, renew training

- Special rules on radioactive materials
- Any shielding modification requires radiation safety officer!
- Report all safety matters to Control Room x4969
- In case of ANY injury call x7911
- Report safety concerns - whether it's in your area or not!!
- Thank you for your cooperation

How can we help you do your  
experiment safely?

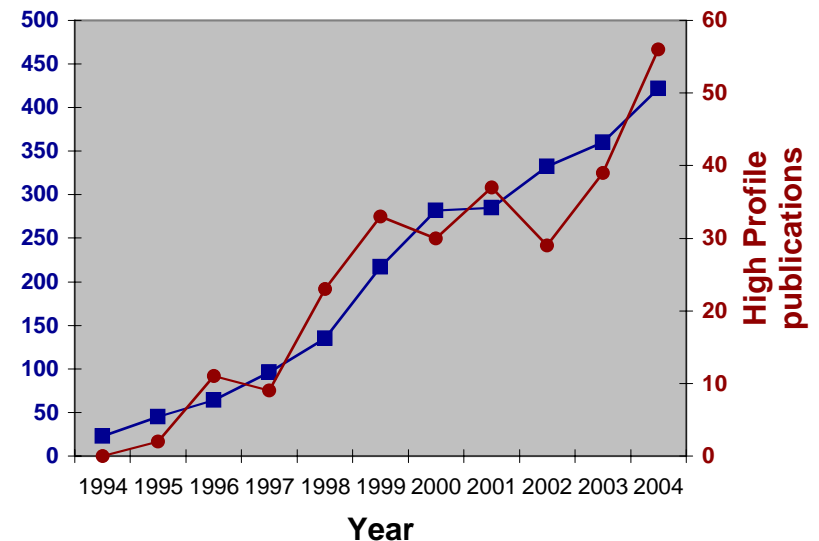
	1999	2000	2001	2002	2003	2004*
<b>Refereed</b>	<b>217</b>	<b>282</b>	<b>285</b>	<b>332</b>	<b>360</b>	<b>422</b>
<b>High profile**</b>	<b>33</b>	<b>30</b>	<b>37</b>	<b>29</b>	<b>39</b>	<b>56</b>
<b>Theses</b>	<b>15</b>	<b>19</b>	<b>21</b>	<b>15</b>	<b>24</b>	<b>21</b>
<b>ALS Total</b>	<b>350</b>	<b>347</b>	<b>397</b>	<b>381</b>	<b>429</b>	<b>456</b>

\* incomplete

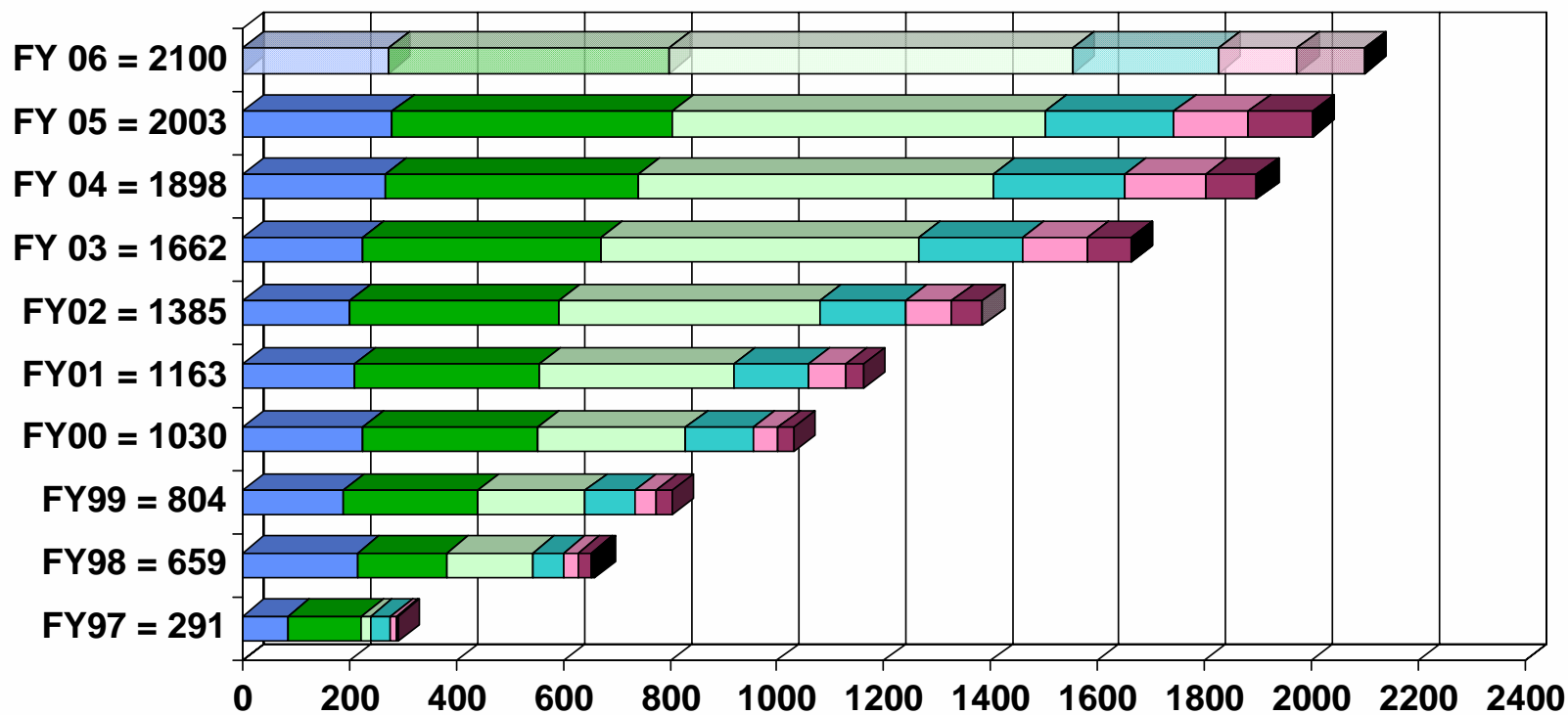
\*\* Cell, Nature, PRL, Science

List includes exclusively  
Publications based on work  
performed at the ALS.

ALS Refereed and High Profile Publications  
1994 - 2004\*



# ALS Users by Discipline



Materials Sci.

Physics

Life Sci.

Chemical Sci.

Applied Sci.

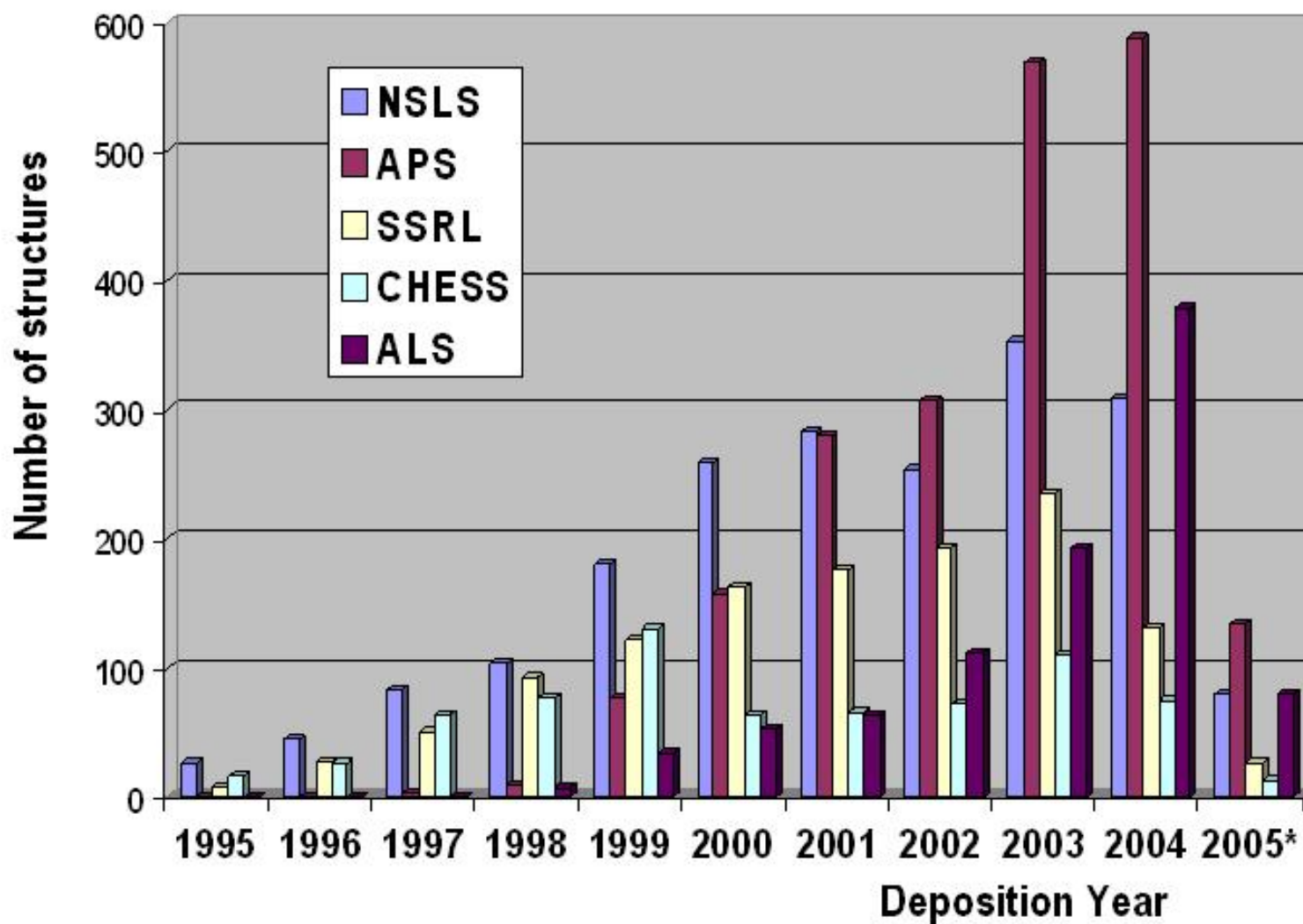
Geosci. & Ecology

Other

Hatched lines indicate projected figures



Fig.3 PDB depositions: US Synchrotron, As of May 11, 2005



# Guest House



# Proposed User Support Building



“...ALS serves as a model for how a user facility should operate.

Congratulations on your outstanding achievements”

Pedro Montano

## Recommendations:

- Begin search for full-time ALS Director

- Recognizing enormous contributions of Daniel

Search Committee chaired by Paul Alivisatos

Committee wants input from users!

- Upgrade proposal review system

In process (Neville, Gary, PSP)

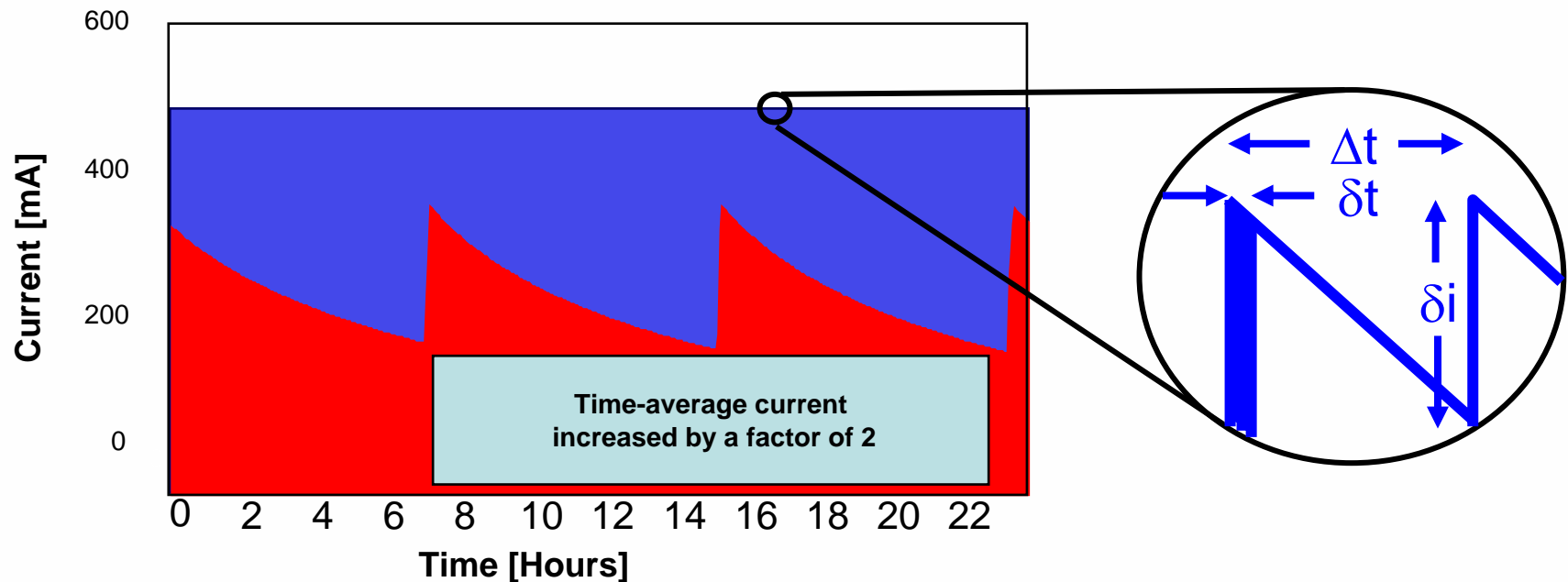
- Enhance beamline support staff

Will do as budget allows

- Machine improvements
- New beamlines on line
  - These expand the science-reach of the ALS
- New science
  - Talks this afternoon and in workshops

In Top-off mode the plan is to run with

- 2 times higher time averaged current
- 3 times smaller vertical beam size



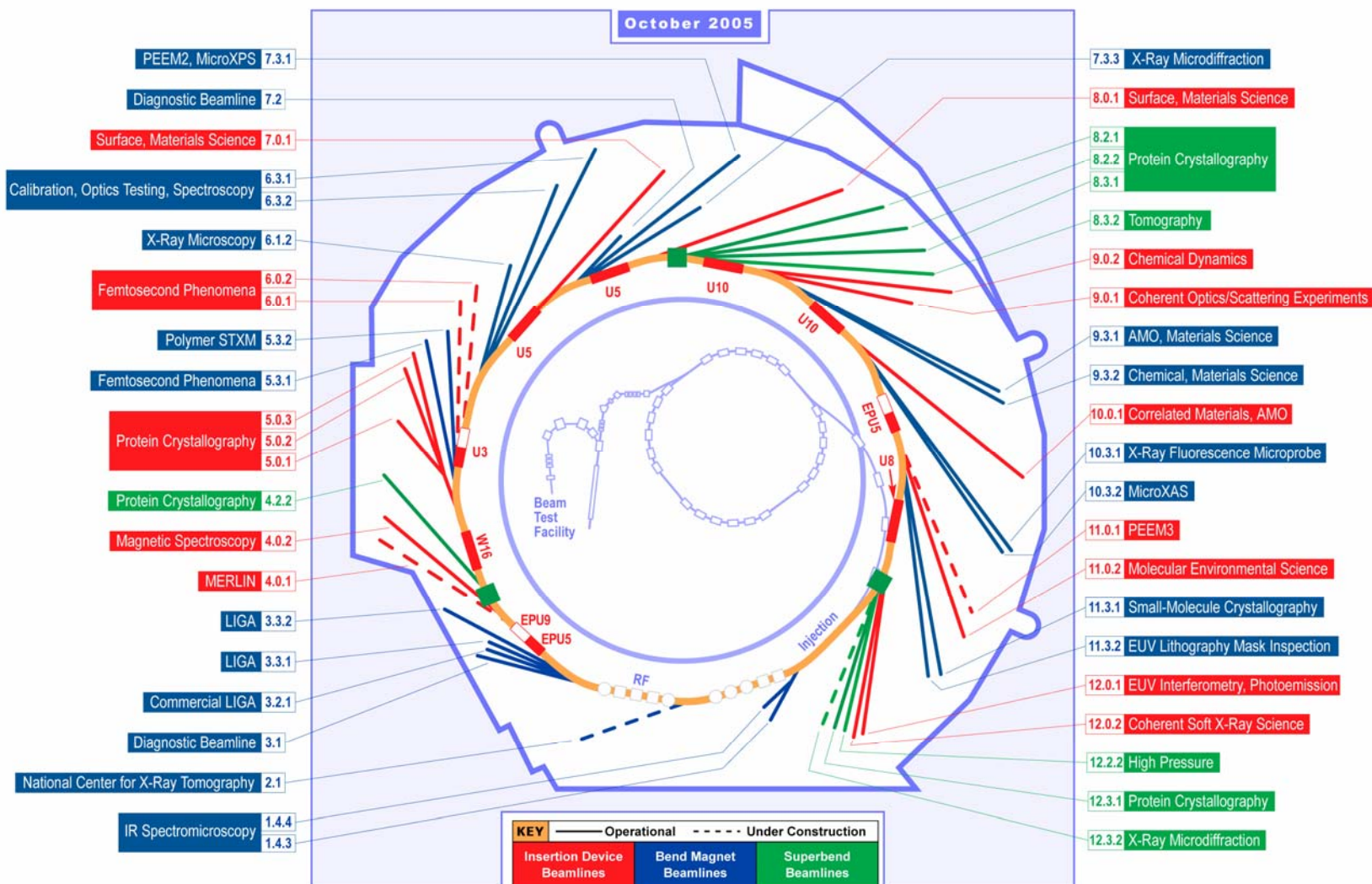
	$\delta i$	$\Delta t$	$\sigma_h$	$\sigma_v$	$\sigma'_h$	$\sigma'_v$
Before Top-off	200mA	8h	298 $\mu$ m	23 $\mu$ m	22 $\mu$ rad	6.5 $\mu$ rad
After Top-off	1.5mA	32.0s	298 $\mu$ m	8 $\mu$ m	22 $\mu$ rad	3 $\mu$ rad

- Conceptual Design Review of the Project in November 2004
- Received 3 M\$ in FY05 from BES in March 2005 (on top of 1 M\$ earlier funding)
- Performed Extensive Testing of Pulsed Magnet Systems
- Finished Design work on major systems
- Began Procurement of the Major Long Lead Items
- Conducted Many Tests and Simulations Concerning Radiation Safety and Began Upgrading the Radiation Protection System

- Extended shutdown will be in Fall 2006
  - Exact date and duration to be determined (6 to 8 weeks including initial commissioning)
- Plan to operate with full-energy injection immediately following the shutdown
- Migrate to full top-off operation during the following six months



# Beamlines at the ALS 2005



**Commissioning starts Jan 06.**

**PEEM3(2) mode April 06 – April 07**

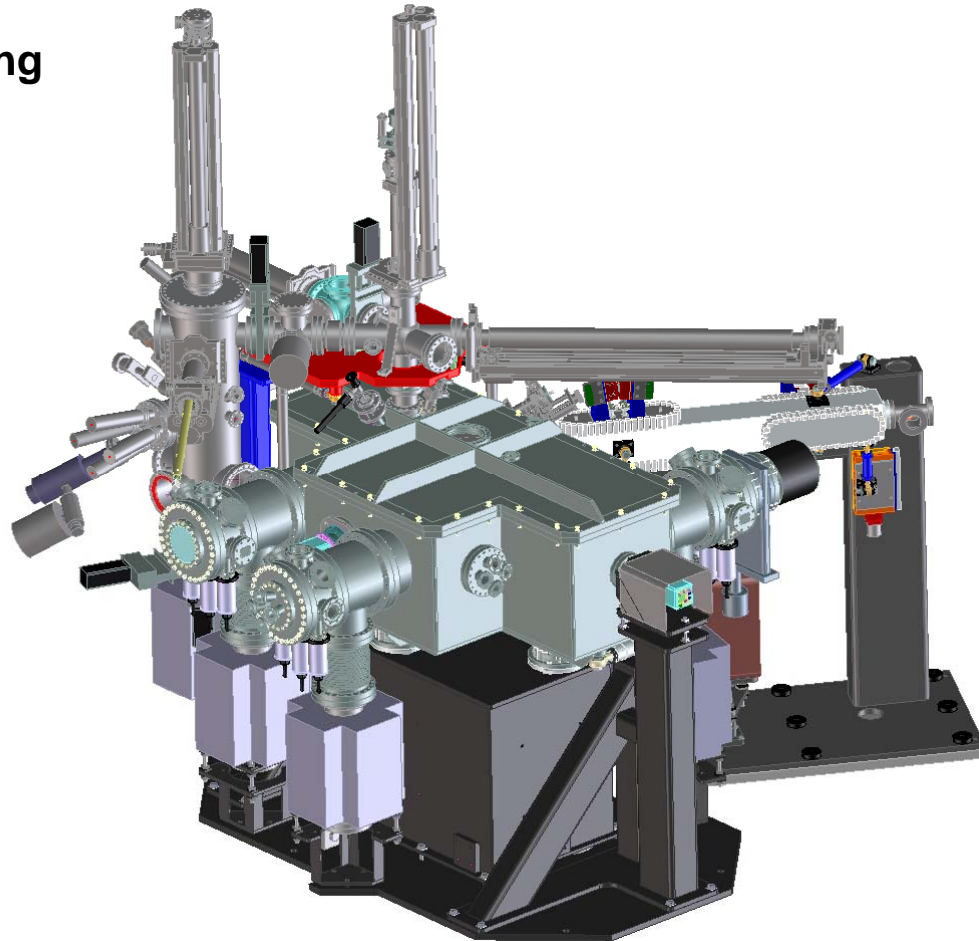
**PEEM3 corrector installation / commissioning**

**- April 07 – Oct 07**

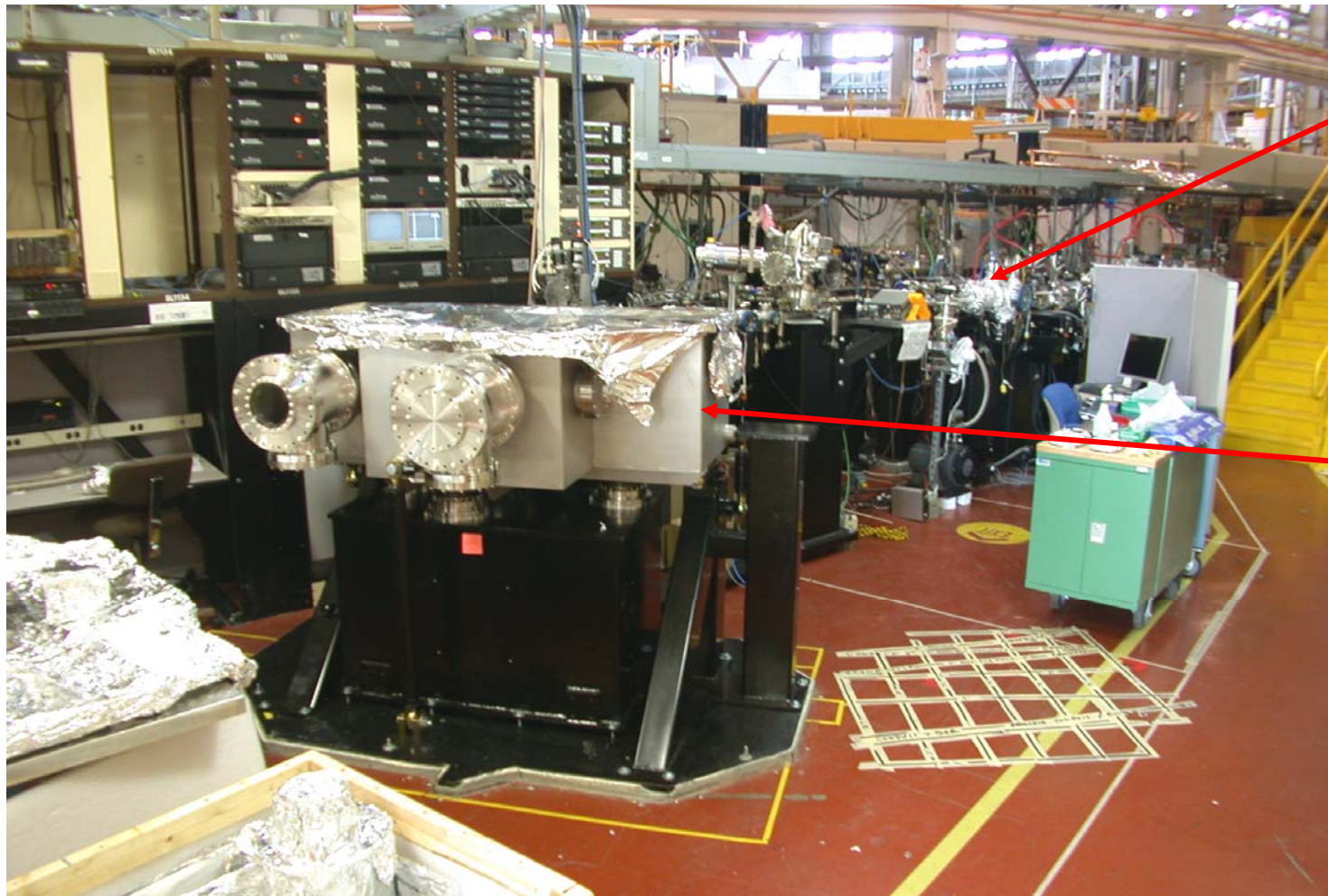
- 1000x flux density of PEEM2**
- full polarization control**
- high resolution mono**
- dynamic measurement of photon E**

**- Aberration correction**  
Required for nano-scale studies

**- Sample Prep chamber**  
Required for thin film and surface studies



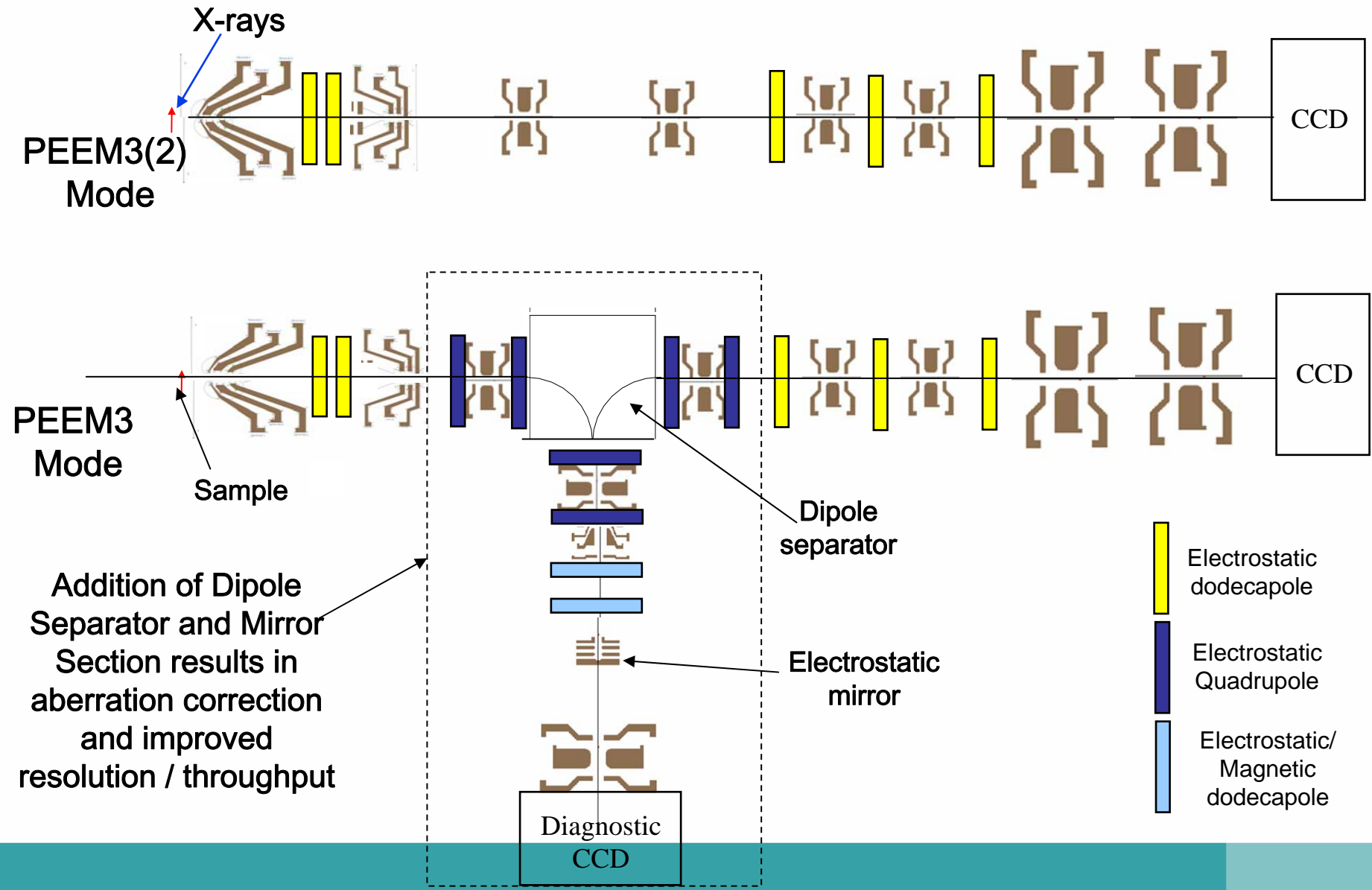


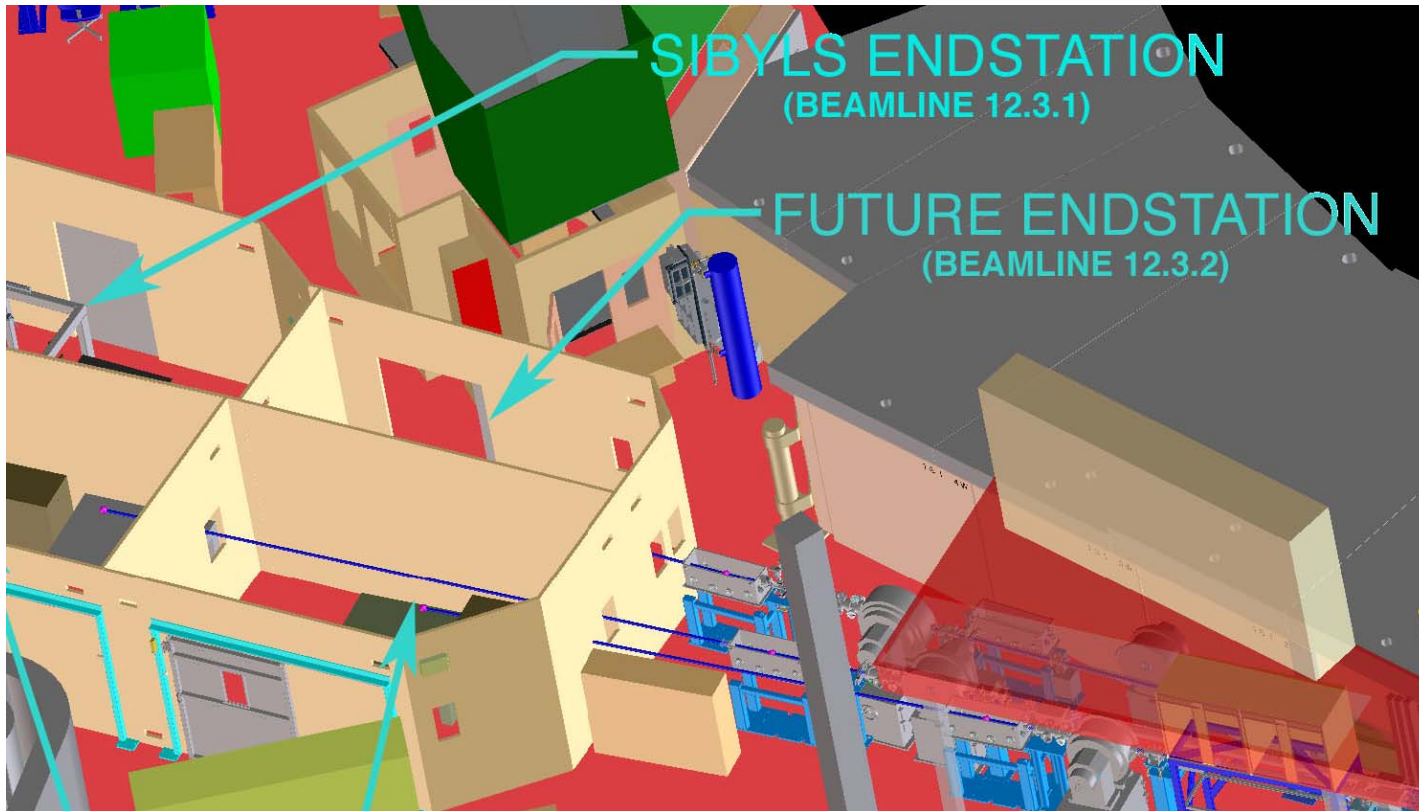


11.0.1  
beamline

Main PEEM3  
Vacuum chamber

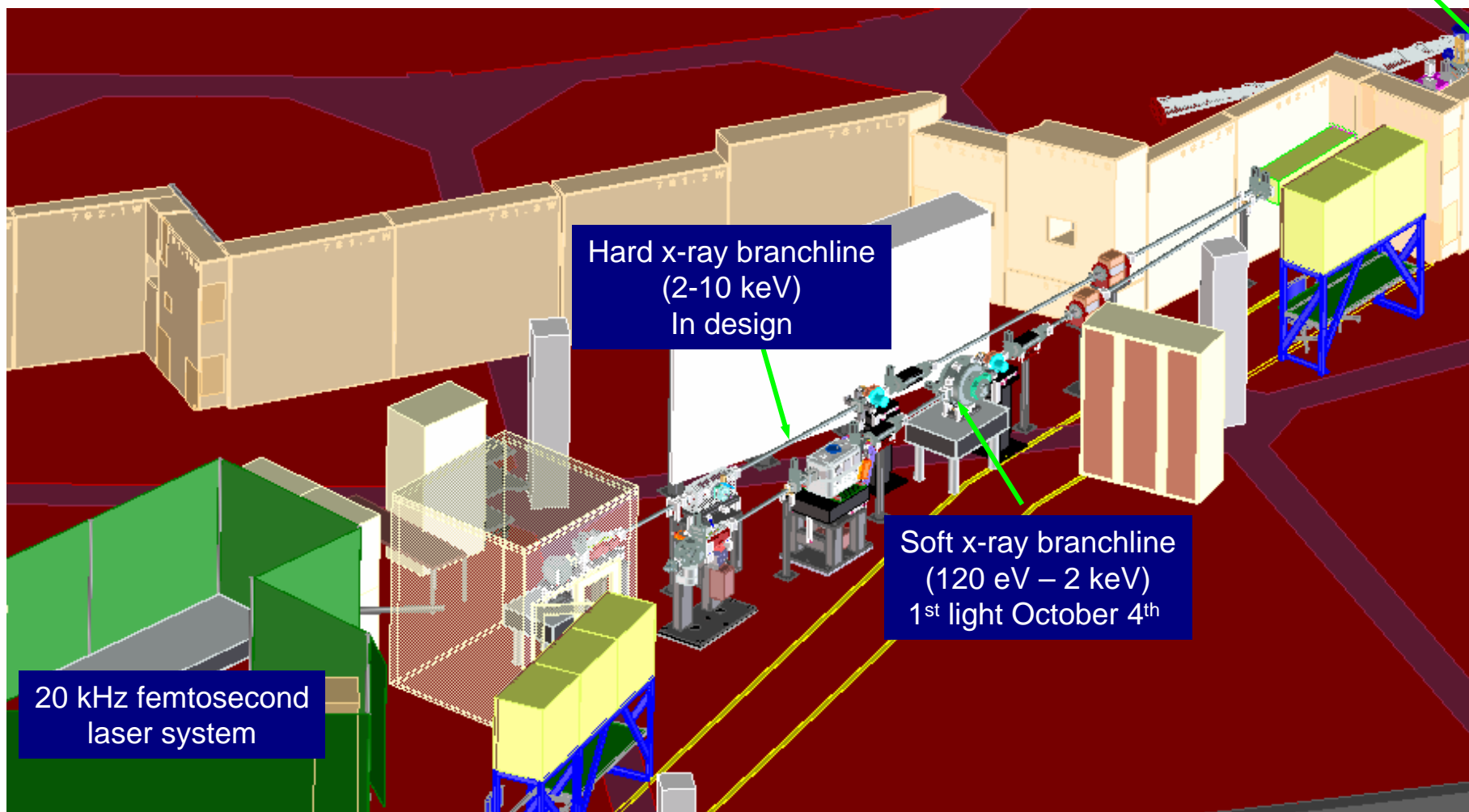
PEEM3 end station



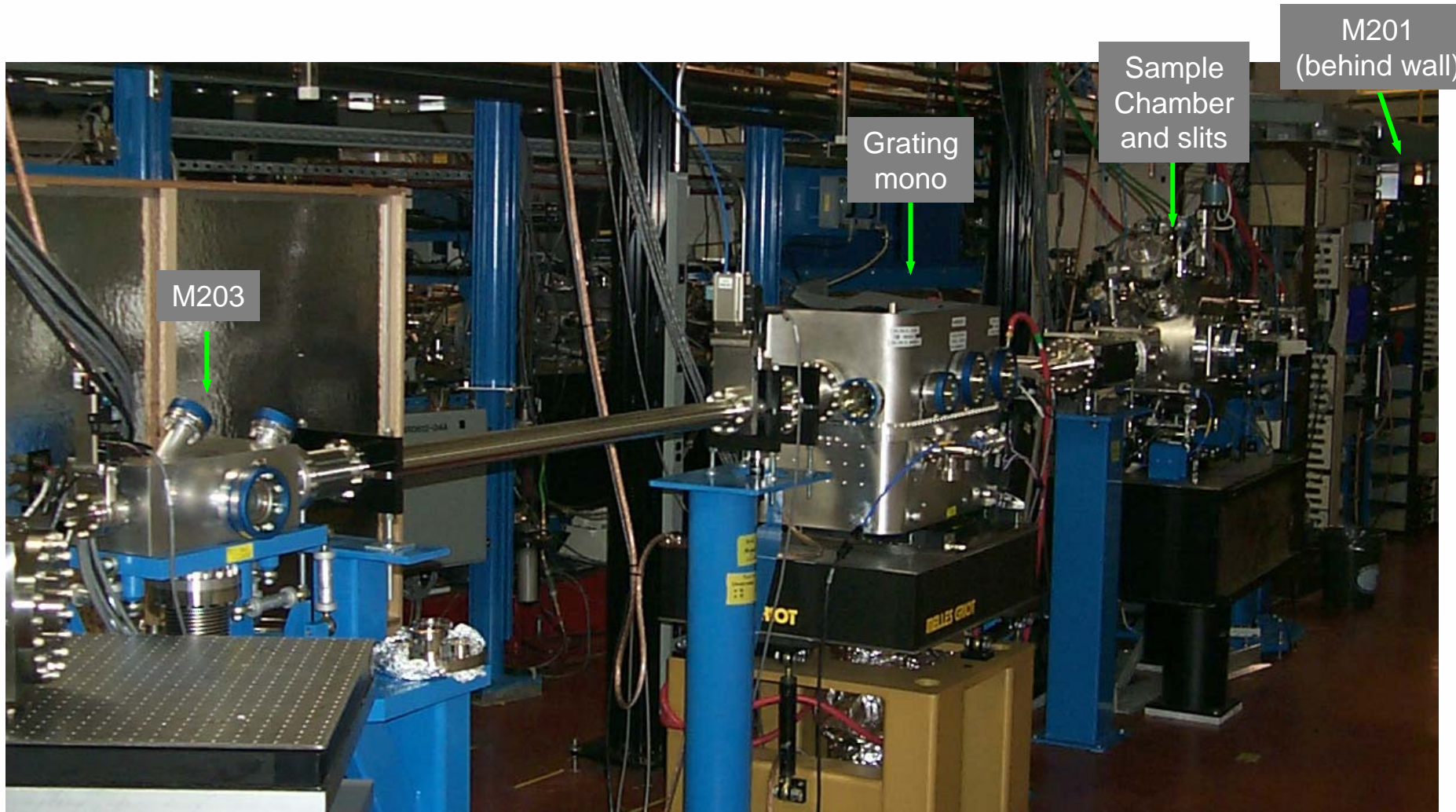


- Very successful 7.3.3 microdiffraction program **Move from 7.3.3 to 12.3.2 late spring 06.**
- NSF funds s/bend hut, array computer, M1 mirror system, endstation (Ustundag PI): ALS Engineering
- Gives access to higher flux and photon energy: better resolution, better strain sensitivity

In-Vacuum  
Undulator





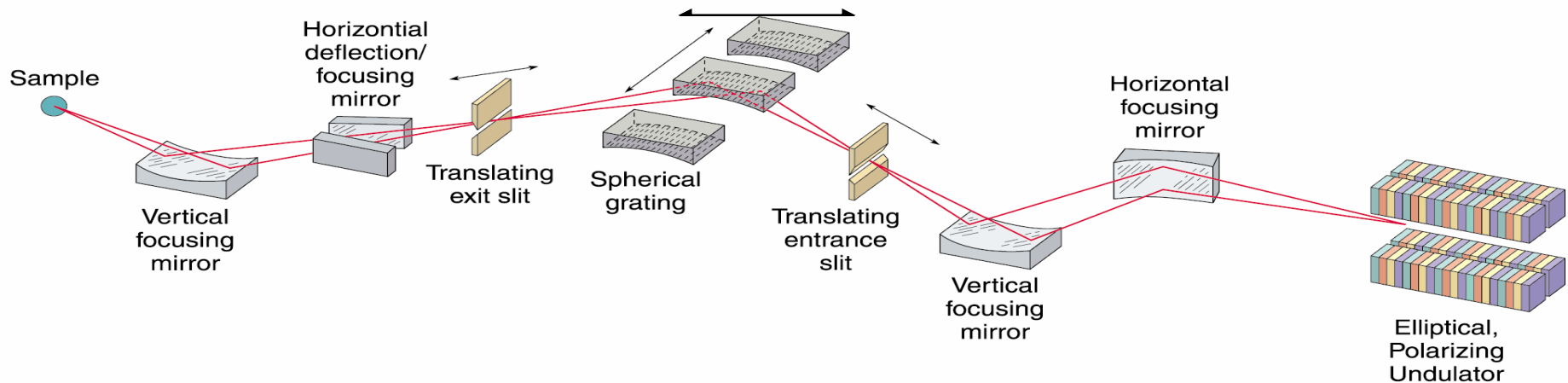


## ➤ Specifications:

- Resolving power:  $E/\Delta E = 100,000$  ( $< 1$  meV for photon energy below 100eV)
- Photon energy range: 15eV to 150eV
- Elliptically Polarized Undulator (EPU): full polarization selection (linear and/or circular)
- Photon Flux:  $\sim 5 \times 10^{11}$  photons/s/meV

## ✓ Progress to date:

- ✓ Optical layout has been optimized (two modes: ultra high resolution (sub meV) and high resolution/high throughput)
- ✓ Floor layout is finalized
- ✓ EPU is specified (quasi periodic undulator to suppress higher orders)

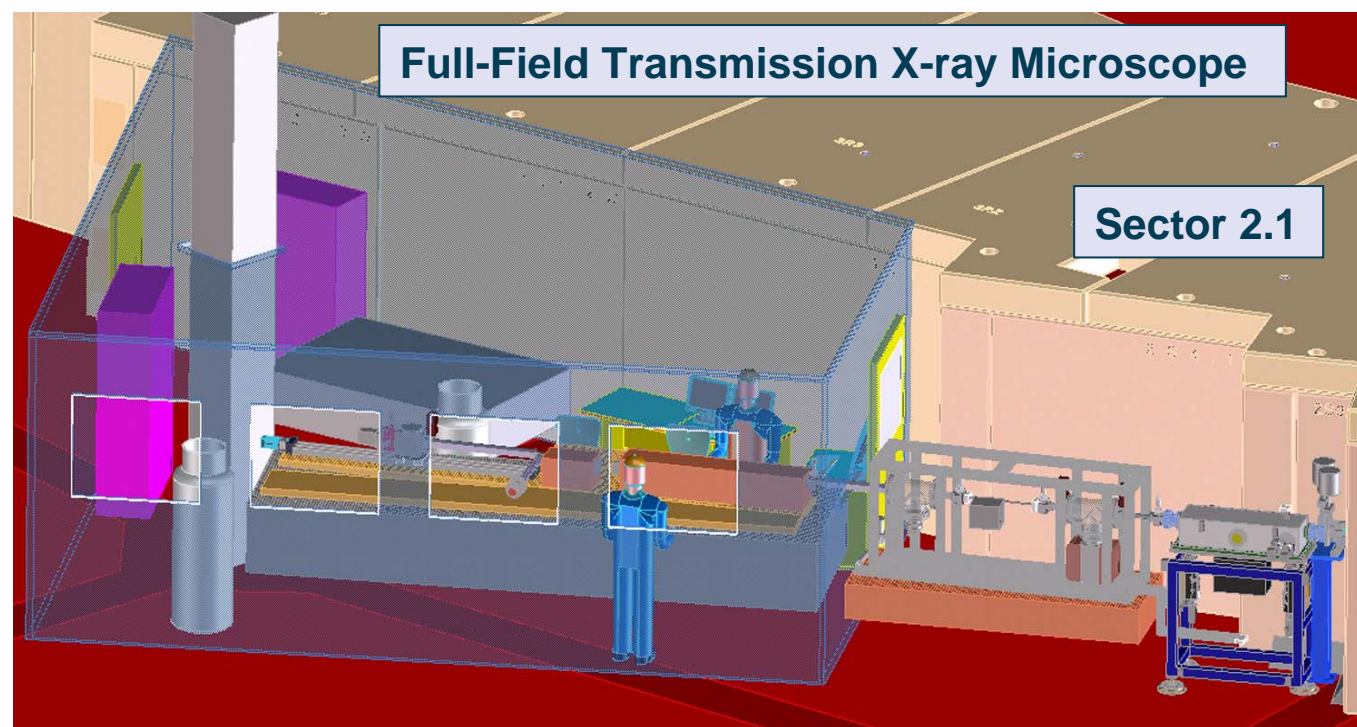


**Optical Layout (variable included angle SGM)**

Planned completion: March 2007



**University of California, San Francisco  
Lawrence Berkeley National Laboratory**

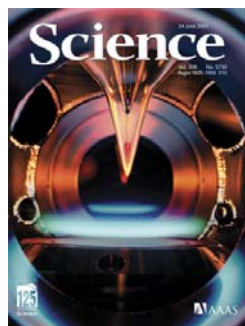
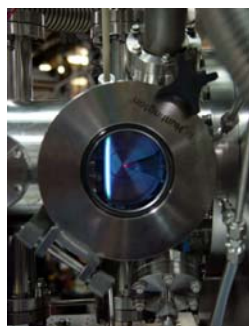
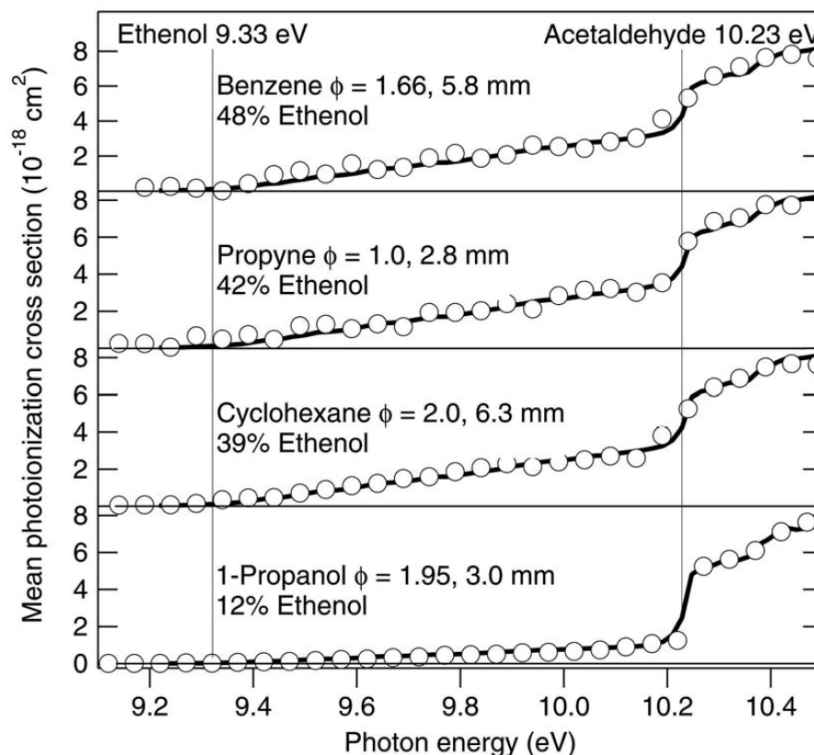
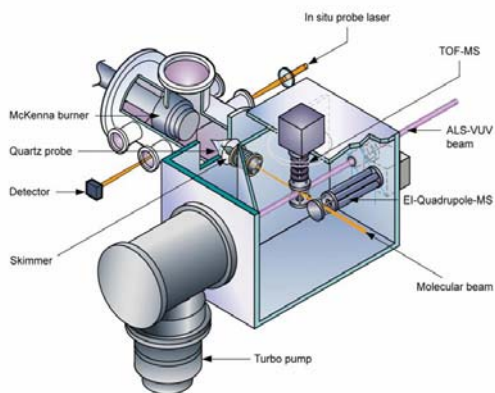


**Carolyn A. Larabell  
Director**

**Mark A. Le Gros  
Associate Director**

**National Center for Research Resources, NIH  
Office of Biological and Environmental Research, DOE**

# Some Science Highlights



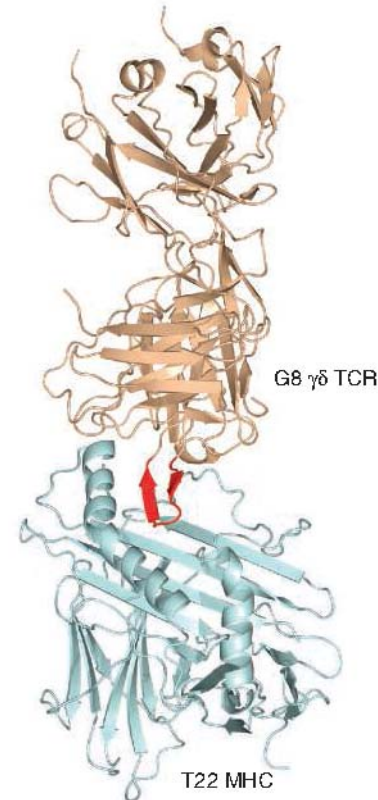
Flame chamber at ALS  
Chemical Dynamics  
Beamline 9.0.2.

*Enols have not been included as intermediates in combustion models but substantial quantities of two-, three-, and four-carbon enols have now been identified by photoionization mass spectrometry of flames burning representative compounds from modern fuel blends, such as the ethanol (acetaldehyde isomer and simplest enol) found here in four flames.*

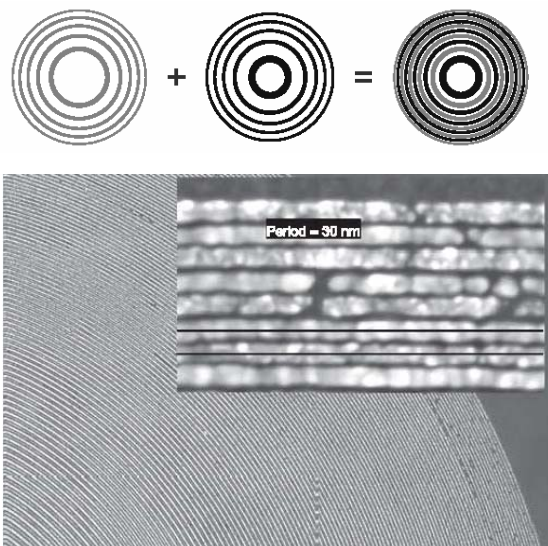
A D V A N C E D L I G H T S O U R C E

C.A. Taatjes (Sandia National Laboratories and JILA); N. Hansen, A. McIlroy, J.A. Miller, J.P. Senosian, and S.J. Klippenstein (Sandia National Laboratories); F. Qi (Sandia National Laboratories and National Synchrotron Radiation Laboratory, China); L. Sheng and Y. Zhang (National Synchrotron Radiation Laboratory, China); T.A. Cool and J. Wang (Cornell University); P.R. Westmoreland and M.E. Law (University of Massachusetts, Amherst); T. Kasper and K. Kohse-Höinghaus (Universität Bielefeld, Germany). [*Science*. **308**, 1887 (2005)]

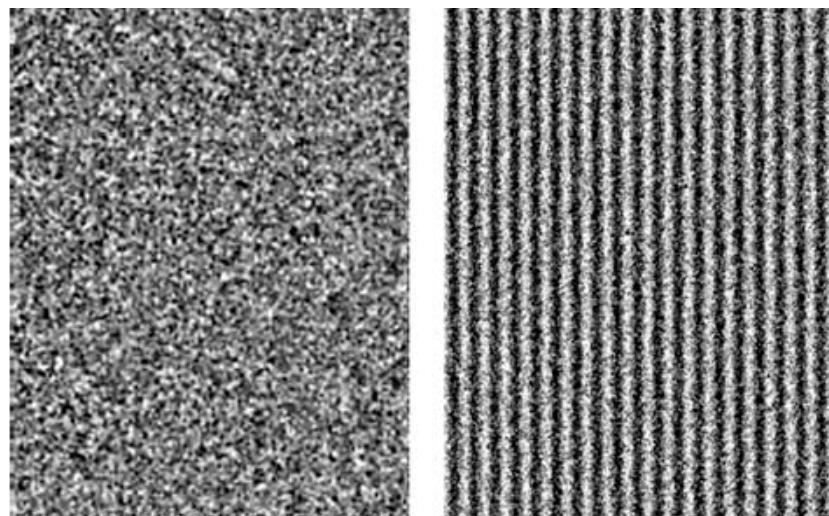
- $\gamma\delta$  T cells thought to be similar to members of the innate immune system.
- Structure provides molecular basis of T cell receptor (TCR) recognition (ALS Superbend Beamline 8.2.1).
- The  $\gamma\delta$  TCR (brown) of the mouse G8  $\gamma\delta$  T cell clone binds to T22 (blue), a nonclassical major histocompatibility complex (MHC) molecule, primarily through its CDR3 loop (red).
- The G8  $\gamma\delta$  TCR seems to hang off the edge of T22 by means of the CDR3 loop that anchors it to the floor of a cavity in the T22 MHC-like molecule.
- The chemistry of the recognition interface between G8 and T22 can be thought of as a hybrid between innate and adaptive recognition solutions.



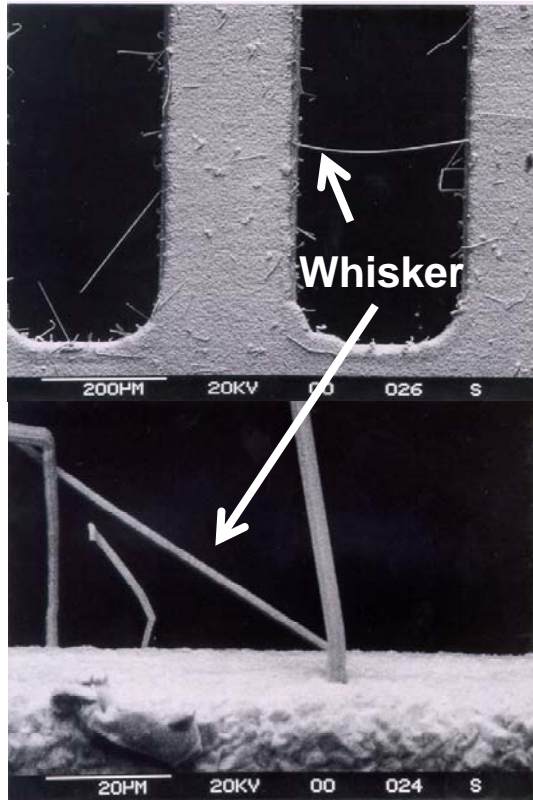




Overlay technique with separate e-beam lithography patterns for odd and even zones achieves 30-nm zone period (center-to-center) with high quality (e.g., placement accuracy of 1.7 nm).



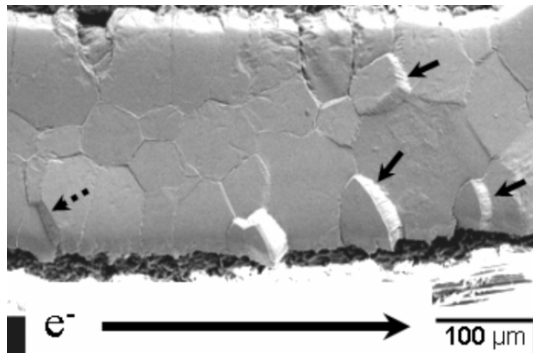
Soft x-ray images taken with the CXRO XM-1 full-field imaging microscope at the ALS (Beamline 6.1.2). Comparison of images of a 15.1-nm test object with the previous 25-nm (left) and the new 15-nm (right) zone plates illustrates the improved spatial resolution achievable.



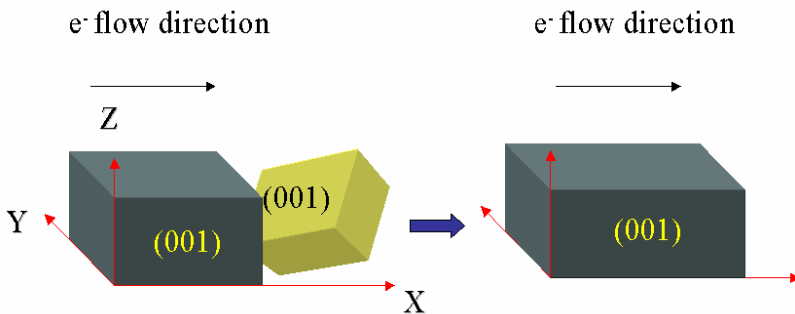
Sn whisker on Pb-free leadframe finish

- For environmental reasons, the electronics industry currently follows a roadmap to completely eliminate Pb in its products (“Pb-free” leadframe finish, solder in flip-chip technology, ...).
- Tin (Sn) and tin compounds are the best alternative to Pb in terms of cost and properties.
- **However Sn offers some operational issues that need to be resolved and these are being addressed with micro-XRD**
  - spontaneous growth of ‘whiskers’
  - **strange electromigration resistance behaviour**
    - eg. initial *reduction* in resistance on current flow
    - investigate grain orientation using **x-ray microdiffraction on 7.3.3**
- Sample is raster-scanned under a micron-sized white X-ray beam focused by Kirkpatrick-Baez mirrors. At each step a Laue pattern is recorded.
- Analysis of the Laue pattern scans provides grain orientation maps, strain/stress maps as well as local deformation distribution.

# Electromigration-induced microstructure evolution in polycrystalline $\beta$ -Sn: results



Post SEM analysis showing alteration of the surface morphology suggesting grain rotation



Proposed grain growth mechanism based on the experimental observations

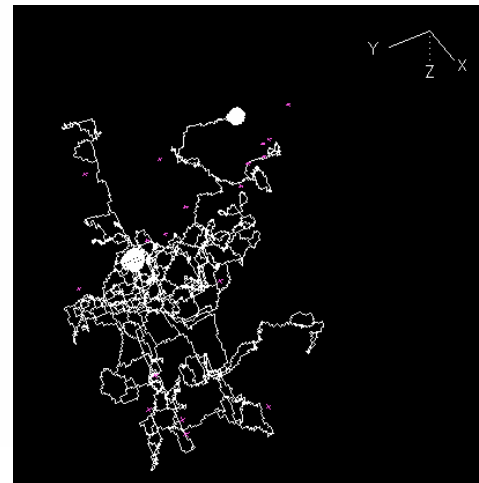
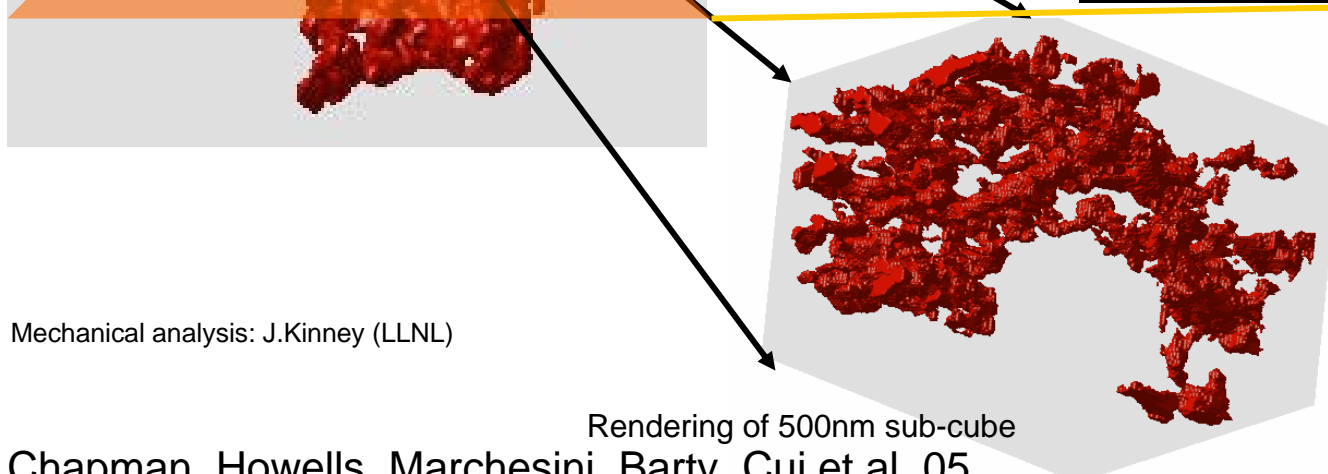
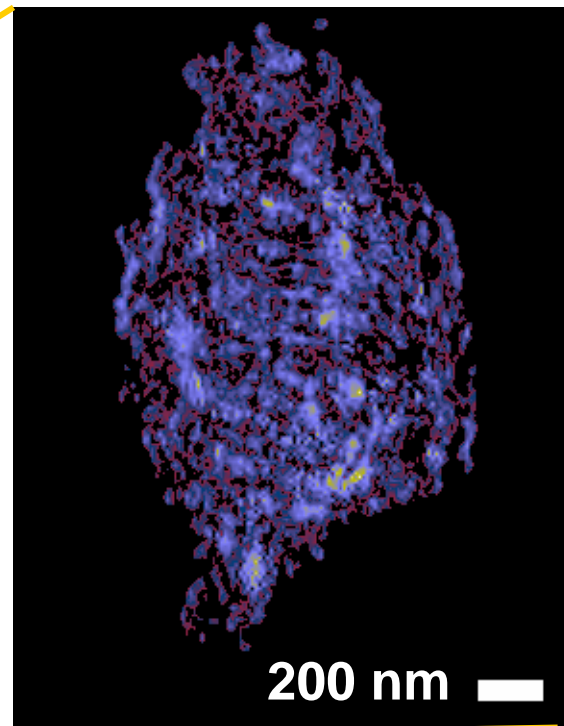
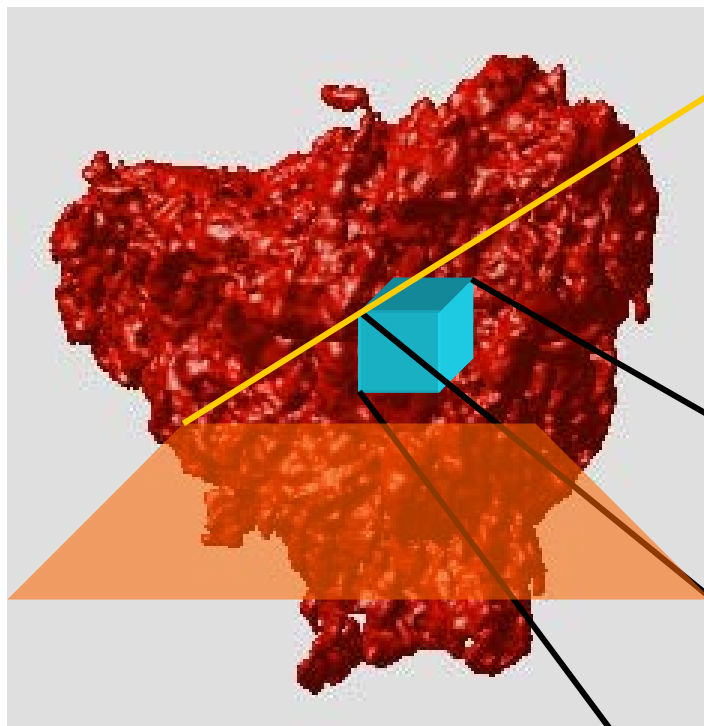
- Tin is characterized by an anisotropy in its electric conductivity.
- The ALS results show the “apparent” growth of favorably oriented (“good”) grains to the detriment of less-favorably oriented (“bad”) ones.
- The X-ray microdiffraction results combined with SEM observations suggest a mechanism of electromigration-induced grain re-orientation of “bad” grains to explain these grain growth .
- Based on these results, a model where “bad” grains neighboring “good” grains rotate under the influence of current has been proposed.
- The amount of grain reorientation is consistent with the experimentally observed drop in electromigration resistance.

Publications: A.T. Wu et al., Appl. Phys. Lett. **85** (2004) 2490

A.T. Wu et al., Appl. Phys. Lett. **86** (2005) 2419061

# 3D Aerogel skeleton structure revealed by Diffraction Microscopy ALS-ASU-LLNL 9.0.1

100mg/cc Ta<sub>2</sub>O<sub>5</sub> Aerogel particle (2μm in extent)



Mechanical analysis: J.Kinney (LLNL)

Rendering of 500nm sub-cube

Chapman, Howells, Marchesini, Barty, Cui et al 05



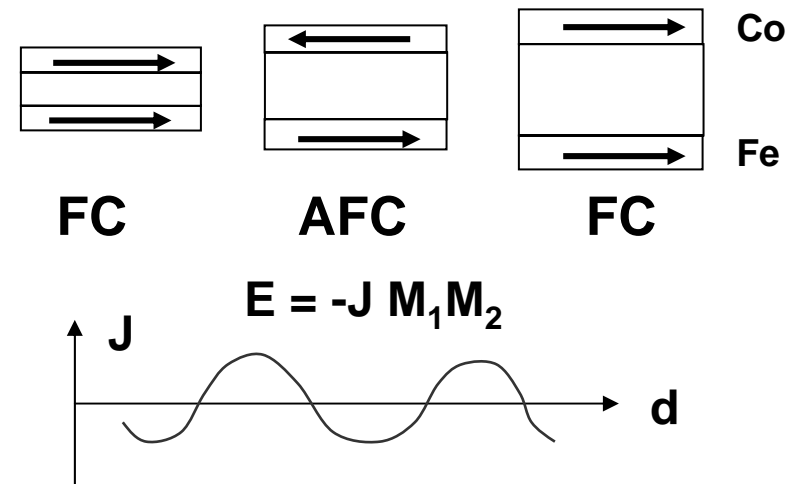
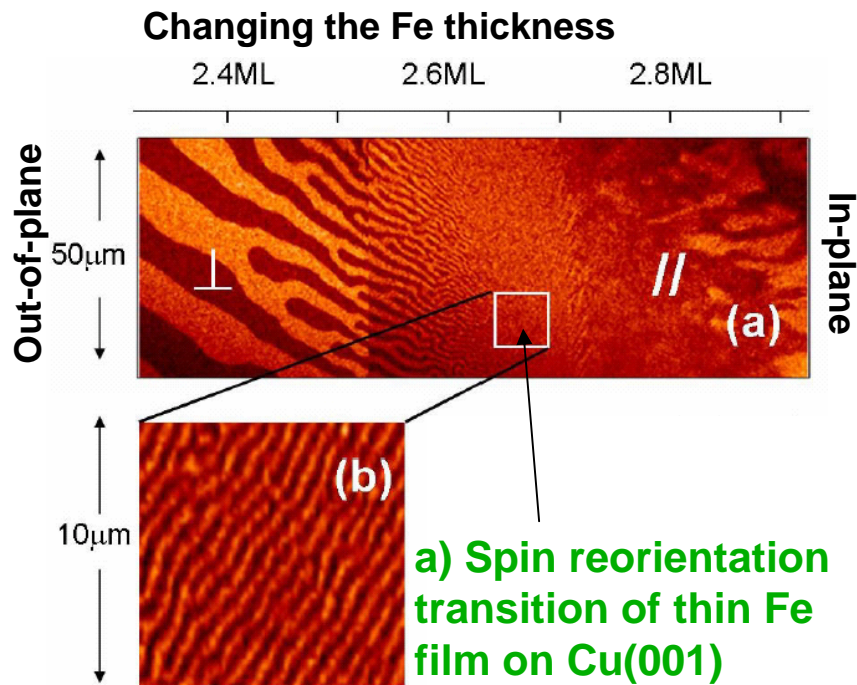


# PEEM Study of Coupled Magnetic Sandwiches



## Motivation

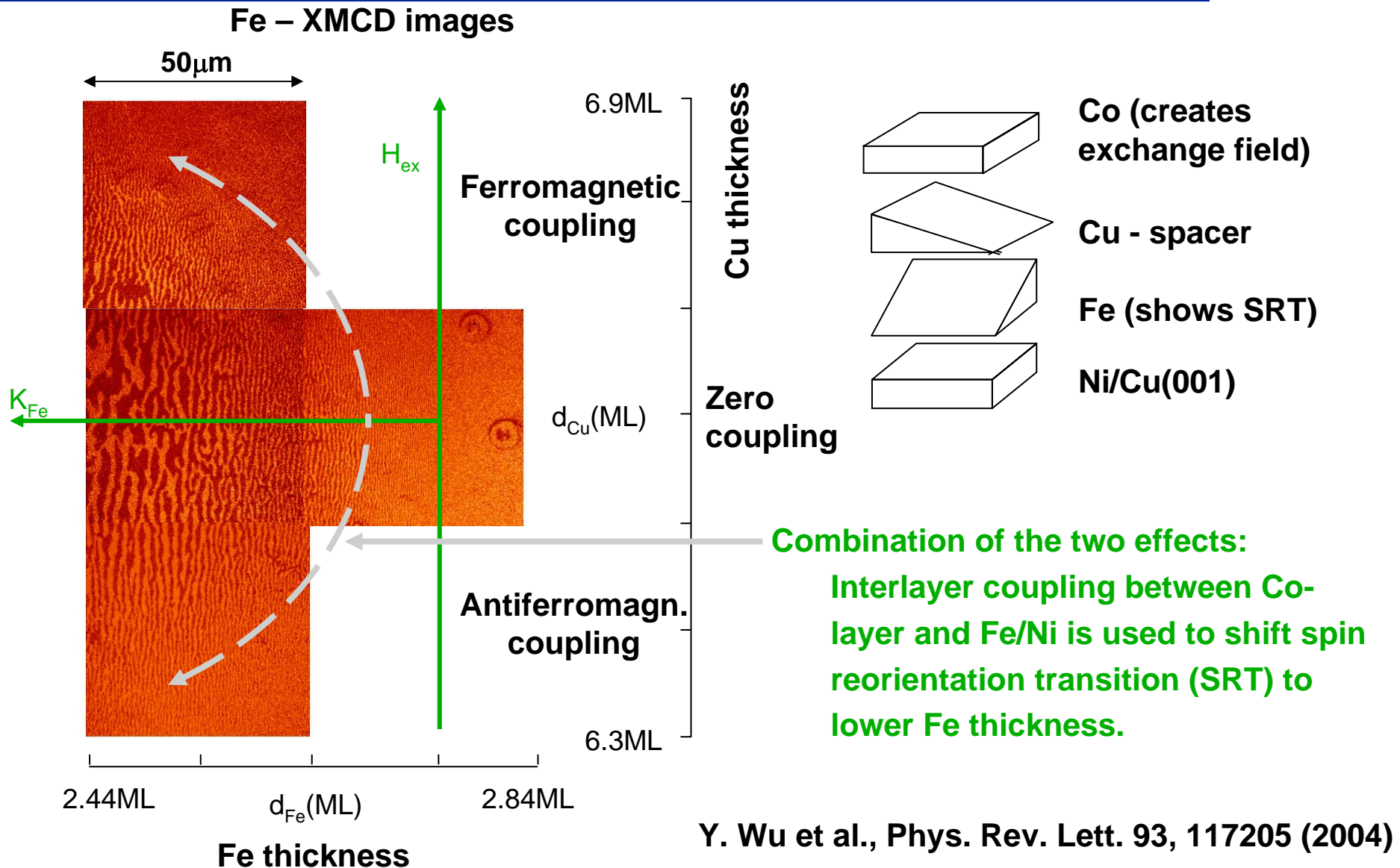
Use the oscillating interlayer coupling as an effective field (exchange field) to modify a magnetic state, here, the spin reorientation transition (SRT).



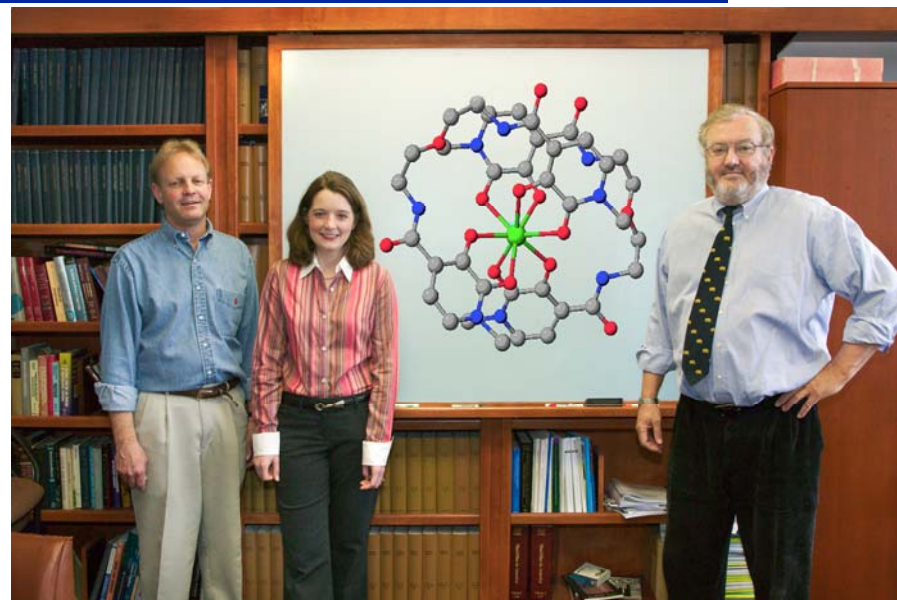
b) Coupling between two ferromagnets oscillates with spacer thickness.



# Interlayer Coupling Shifts SRT



# Sequestered Plutonium: $\text{Pu(IV)[Bis(5-LIO-Me-3,2-HOPO)]}^{2-}$ The 1<sup>st</sup> Structurally Characterized Plutonium Hydroxypyridonate Complex



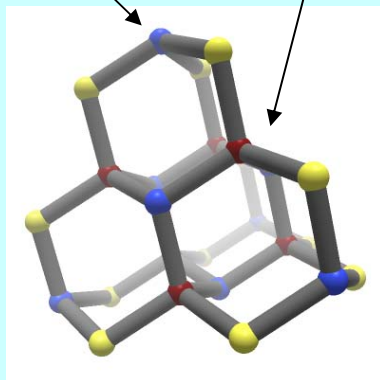
Anne E. V. Gorden, David K. Shuh, Bryan E. F. Tiedemann, Richard E. Wilson, Jide Xu, and Kenneth N. Raymond

Chem. Eur. J. 11, 2842-2848 (2005)

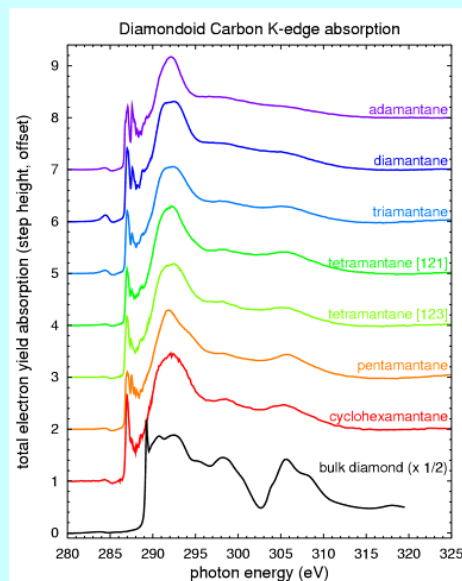
Work supported by U.S. DOE Division of Chemical Sciences,  
Geosciences, and Biosciences at LBNL and ALS  
BL11.3.1

**Soft x-ray absorption measurements of diamond clusters show that unoccupied density of states do not exhibit any quantum confinement shift (unlike Si and Ge) and that surface dominates the lowest states**

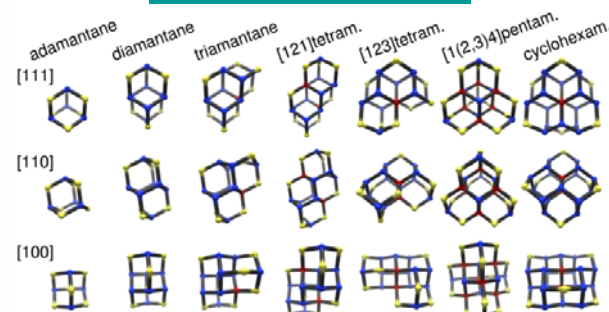
H-terminated surface  
"Diamond" core



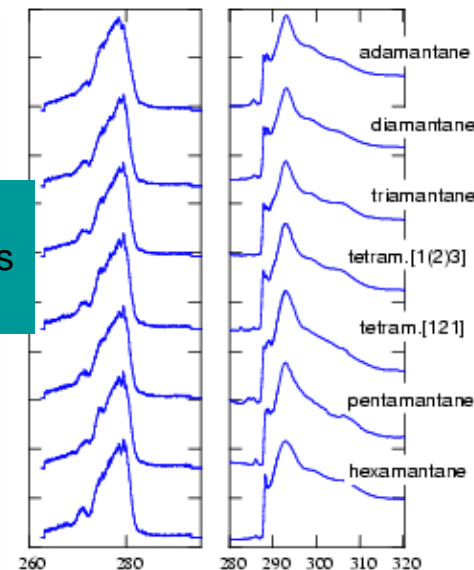
Pentamantane



## Diamondoids



Occupied  
Electronic States  
vs. Unoccupied



T. M. Willey, C. Bostedt, T. van Buuren, J. E. Dahl, S. G. Liu, R. M. K. Carlson, L. J. Terminello, and T. Möller  
*Physical Review Letters* **95**, 113401 (2005)

Virtual Journal of

**Nanoscale Science & Technology**

a weekly multijournal compilation of the latest research on nanoscale systems



Keeping the ALS at the cutting edge  
for next decade

**Compelling scientific case**

Better serve the User Community

Orderly Upgrade at moderate cost

## Ingredients

- **Machine Upgrade**
  - Increased brightness and stability
  - Modern undulators
- **Science enabled by upgrade**
  - Address Grand Challenges
  - DOE/BES priority areas
  - strength of user community
- **Coordinate with strengths and needs of**
  - Molecular Foundry
  - CXRO
  - Ultrafast program
- **Further improve service to users**
- **Cognizance of SPEAR III and LCLS**

- 2004: Draft Strategic Plan developed with user input
- Approved @SAC Meeting Dec 2004
- Presented @ BES Review Feb 2005
- Posted on ALS web site March 2005
- Workshops to refine plans, prepare cost estimates, build scientific case, spring/summer/fall 2005
- Update plan as needed

# Planned new facilities

## Wave 1

- Coherent scattering and diffraction microscopy
- Nano-ARPES
- Soft X-ray scattering

## Wave 2

- Chicane Sector 10 with EPU's
- Ultrafast magnetism
- Q resolved inelastic scattering

## Wave 3

- Bend magnet beamline with 1 ps pulses by crabbing
- CIRCE



- Staffing for the beamlines  
(and more diversity!)
- Detectors
  - (the rate-limiting component in the efficient use of much of the the facility)
- Optics
- User support building
- Guest House

- G. Fleming: Next major facility for LBL?
- Workshop August '05: Upgrade the ALS!
- Increased brightness
- Short pulse options
- What are the future needs of the User Community?
- Next steps: Input from UEC, SAC,...

**Support users in doing  
outstanding science  
In a safe environment**

Berkeley Lab FRIENDS of SCIENCE

Public Lecture in Association with the

- Advanced Light Source Users' Meeting and
- The World Year of Physics

## The Magic of Magnetism: From Physical Attraction to Spin Doctors

by **Dr. Joachim Stöhr**, Director  
Stanford Synchrotron Radiation  
Laboratory



Berkeley Lab's Building 50 Auditorium  
Thursday, October 20, 2005  
7:15 - 8:30 p.m.

- We are grateful to DOE/BES for continuing support
- The ALS continues to grow, and we have ambitious plans for the future
- Safety must remain top priority
- The ALS and its user community has a lot to be proud of.
- Search for permanent Director just beginning
  - Truly exceptional group of people!
  - I am most grateful for your support,  
and for the opportunity to serve
  - Daniel deserves a lot of credit